SPECIES

Diversity of Macroinvertebrate Fauna in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon

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ABSTRACT

The study assessed the diversity of macroinvertebrate fauna in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon. Specifically, the study aimed to: a) Determine the morpho-species composition of macroinvertebrates; b) determine the species diversity of macroinvertebrates; and c) assess the local status of macroinvertebrate species in the study area. The study was done during the month of March 2022 with a sampling effort of 12.5 hours per day once a week. Three different study stations were made. Station 1, the upstream, was geographically located at 8°00'02.8"N 125°07'36.3"E. Station 2, the midstream, was geographically located at 8°00'02.8"N 125°07'35.9"E and Station 3, the downstream was geographically located at 8°00'03.0"N 125°07'35.6"E. Dip netting, surface netting, rock rubbing, light trapping and opportunistic sampling method was employed. A total of 1,924 individuals were collected in three stations belonging to ten order and thirteen families. Common families present in all stations were the family Atyidae, Platycnemididae, Hydraenidae, Culicidae, Thiaridae and Viviparidae. Of all taxa recorded, only *Melanoides* sp. (36%), *Caridina* sp. (26%) and *Sinotaia* sp. (9%) were the most represented taxa. Overall, the diversity of aquatic macroinvertebrates in Nasuli Spring is low based on the classification scheme for the Shannon-Weiner diversity index of the Kruger scale. Signs of human disturbances were evident in the results of decreasing macroinvertebrate diversity. Berger-Parker Index showed that Station 1 is the most disturbed (69.602%), followed by station 2 (62.369%) and station 3 at 43.099%. The assumption that the aquatic macroinvertebrate diversity is high in Nasuli Spring, Bangcud, Malaybalay City is not accepted.

Keywords: Macroinvertebrates, spring, diversity, local status

1. INTRODUCTION

Macroinvertebrates are organisms with no backbone and are large enough to be seen with the naked eye (Walker et al., 2018). Macroinvertebrates are diverse groups, including insects such as dragonfly larvae, mosquito larvae, beetles and snails. They are found in nearly all stream and river types worldwide and spend at least a part of their lives dwelling on the aquatic floor. Macroinvertebrates are

ecologically and functionally important in numerous terrestrial and aquatic ecosystems. They are a part of virtually every Fresh water ecosystem, even those seemingly inhospitable to life. Macroinvertebrates are involved in nutrient cycles, primary productivity and translocation of materials and breakdown of organic material within the aquatic environment (Wallace and Webster, 1996). Macroinvertebrates can also be used as indicators of the water quality of an aquatic system at a specific location (Arimoro and Keke, 2016), as macroinvertebrates have limited movement and can remain immobile in one area for lengthy periods.

Regarding species diversity, invertebrates make up over 97 percent of all animals on the earth (Karam-Gemael et al., 2020) and insects have the most significant number of species among all animal species. Insects belong to the phylum Arthropoda and have developed into millions of species, especially beetle insects (Curriculum Research & Development Group, 2022). Nevertheless, invertebrates remain underrepresented on both IUCN Red Lists. Invertebrates are the least studied group in terms of conservation, accounting for only 31% of all animal assessments in the Red List (IUCN, 2019). Invertebrates are also among the least well-represented taxonomic groups nationally (Zamin et al., 2010).

Nasuli Spring is a Fresh water lagoon at Barangay Bangcud, Malaybalay City, Bukidnon. The spring is a famous picnic spot frequently visited by locals and tourists for a quick swim and cool getaways. The source of the water and cold temperature comes from the spontaneous flow of groundwater to the earth's surface. In addition, there is a portion of the spring where one can have a foot fish spa and tall trees surrounding the area are an attraction that supplies fresh air and a cool breeze (Malaybalay City Tourism Office, 2021).

While there are still no studies on both flora and fauna in Nasuli spring, this study addresses the deficiency of data regarding the macroinvertebrate fauna of Nasuli Spring. The assumption is that aquatic macroinvertebrate species in Nasuli Spring are still diverse even if the place is exposed to human activities like swimming and diving.

The study's general objective was to determine the diversity of macroinvertebrate fauna in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon. Specifically, the study aimed to determine the morpho-species composition of macroinvertebrates, determine the species diversity of macroinvertebrates and assess the local status of macroinvertebrate species in the study area.

This research study provided information about the aquatic macroinvertebrate diversity in Nasuli Spring and could be an essential input for future studies. Furthermore, the study can also be used to manage, monitor and promote the conservation of macroinvertebrate species and their associated habitats.

The study was limited only to the aquatic macroinvertebrates. For the identification of samples, only the morphological characteristics of macroinvertebrates were covered throughout the study, but the anatomical studies of aquatic macroinvertebrates were not included. The egg of aquatic macroinvertebrates was also not included, but the larvae and adult aquatic macroinvertebrates were collected. Identification of species was limited to the family level to maintain consistent data collection since this was one of the criteria in the USEPA (1997) guidelines for the taxonomy of organisms. Sampling stations were located only in human-accessible areas.

2. MATERIALS AND METHODS

Entry Protocol

Prior to the study, permission was given verbally to the owner of the study location and a letter noted by the adviser and endorsed by the department chair was given to the owner afterward. A Wildlife Gratuitous Permit (WGP) was also obtained from the Department of Environment and Natural Resources (DENR).

Place and Duration of the Study

The study was conducted in Nasuli Spring, located in Barangay Bangcud, Malaybalay City, Bukidnon (Figure 1). Nasuli Spring has an estimated area of more or less 2,500 sq.m with coordinates 8°00′02″ N 125°07′36″E. The study was conducted during the month of March 2022, every Thursday afternoon, around 3:30 PM to 5:00 AM on the following day.

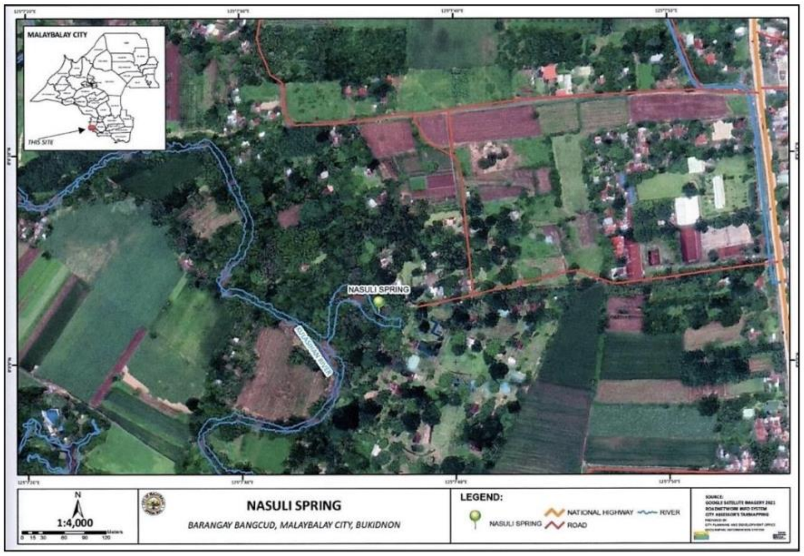

Figure 1 Place of the study. Map of Malaybalay City, Bukidnon showing the location of Nasuli Spring (Google Satellite Imagery 2021 Road network Information System City Assessor's Trans mapping)

Establishment of Sampling Stations

Three study stations were established and labeled as Station 1, Station 2 and Station 3. A Global Positioning System (GPS) was used to determine the exact location of sampling stations with corresponding coordinates and accessibility was considered in selecting stations. Station 1 (upstream) is geographically located at 8°00'02.8"N 125°07'36.3"E. It has a rocky substrate. Human activities are present in this station, like swimming and it is also a common area for a foot fish spa. Aquatic grasses are also observed along the area. Station 2 (midstream) is geographically located at 8°00'02.8"N 125°07'35.9"E. It is near the bridge. It has clear water and a muddy substrate. Aquatic grasses are also observed along the area. Customers do not usually visit and swim at this station since there are no benches to stay and bamboo rafts used by the workers everyday were anchored in this area. Station 3 (downstream) is geographically located at 8°00'03.0"N 125°07'35.6"E. Station 3 is a tributary connecting to the river. It is rocky and has clear water. Epiphytes, vines, grasses and different trees like bamboo and palm trees were also observed along the area. No human activities are present in station 3 since the management prohibits visitors from entering this station for safety purposes.

Sampling Procedures

A dip net was used for capturing organisms below the water surface. Dip netting involves a D-frame net with a 250 µm mesh size attached to a long rod. The sampling procedure of dip netting was done in a three-minute kick and sweep method (Nelson and Wydoski, 2008). It was done by placing the net on the stream bed and disturbing the substratum immediately in a vigorous kicking motion while moving sideways across the stream. The heel or toe dug deeper into the ground to remove organisms. The net was then backwashed to remove extra dirt and organic materials, being careful not to lose the organisms captured. The net contents were then poured into a bucket with some water. Forceps or fingers were used to pull off anything stuck to the net. This was done three times in each station. A surface net was used for capturing organisms on the water's surface. The surface net consisted of a 1mX1m frame with a 250 µm mesh size. The net was placed against the water for 3 minutes and the contents of the net were then poured into a bucket with a little water. Forceps or fingers were also used to pull off anything stuck to the net. This was done three times in each station. Rock rubbing was used to collect organisms attached to the rocks. It was done by picking up large stones and the hand rubbed the rock. The captured organisms from the rock were then placed temporarily in a bucket with a little water for sorting and counting. This was done three times in each station. Light trapping is commonly used for insect biodiversity studies (Sheikh et al., 2016). A 500 W LED powered by solar, 2x4 meters of white cloth and rope were used. Light trapping was conducted from dusk till dawn, around 5:30 PM-5:00 AM. This method was done by placing a rope between two poles and the 2x4 meters of white cloth were hung over the rope. The LED light was then set against the white cloth. The macroinvertebrates trapped in the fabric were then carefully captured and placed temporarily in a suitable jar for sorting and counting. For species enhancement, an opportunistic sampling method was employed. This method was used to document macroinvertebrates outside the study area. Areas around the sampling stations were scanned for macroinvertebrate species to enrich listings.

Sorting and Counting of Samples

All the organisms captured from different sampling methods were appropriately sorted. Sorting took place at a convenient location, ideally near the site. Representative organisms were collected and identified locally. Those that were hard to recognize were marked correctly. The remaining organisms collected for every sampling period were still placed temporarily in suitable jars and released after the study. To ensure the survival of the samples, food plants were included.

Preservation of Specimens

Collected representative samples, identified and unidentified, were preserved in 90% ethyl alcohol in vials. The samples were labeled with the collector's name and the collection date, plus detailed data for the respective (sub-) site, including a site code adapted from Freitag, (2013). For vouchers, two samples per species were preserved.

Classification, Identification and Description of Macroinvertebrates

The specimens were brought to Central Mindanao University, Musuan, Maramag, Bukidnon, for identification. The specimens were classified, identified and described based on morphological characteristics like their head, thorax, abdomen, aperture, eyes, legs, number of whorls, rostrum presence, proboscis, etc. Photographs from reference books, literature and journals on Aquatic Macroinvertebrates like Bouchard, (2004), Yule and Yong, (2004), Oscoz et al., (2011), Wallace, (2003), Fofonoff et al., (2018), Garcia et al., (2018) and Pelingen et al., (2021) were utilized. Furthermore, the identified specimens were verified by experts from Central Mindanao University, Musuan, Bukidnon.

Diversity Indices

A diversity index is a mathematical assessment of species diversity in a community. It is calculated based on the species richness (number of species present) and species abundance of the community (number of individuals per species). To determine the diversity of Aquatic Macroinvertebrates in Nasuli Spring, like species richness, species accumulation (K-dominance), Shannon-Weiner Diversity indices, Bray-Curtis Cluster and Berger-Parker indices, all the important data were encoded in Microsoft excel. They were run in the Biodiversity Professional Statistics Analysis-Software version 2.0.

Physico-Chemical Parameters

The following Physicochemical parameters of each study area were determined in each station and recorded during every sampling period. Water temperature was measured using the digital handheld thermometer and submerged in the water column for three minutes. Three (3) trials were done and the average temperature was calculated. The determination of pH was measured using the calibrated pH meter. It was submerged in the water's surface for 5 seconds. The reading of the pH meter was recorded directly. Every station was divided into three portions: Left side, middle and right side. The reading was done once in every portion of each study station and the average pH was calculated. Water depth was measured using a calibrated rope with a weight attached at the rope's end. Weights were used to ensure the rope sank at the water column's bottom. The calibrated rope was submerged in the middle part of the selected study station. The depth to water is the difference between the reading at the reference point and the level of the ground contact. The water current was determined by establishing a five-meter transects line along the length of the middle part of the study area. The two ends of the five-meter transect line were marked as start and finish. A Ping-Pong ball was then placed at the starting point and the required time for the Ping-Pong ball to reach the finish point was measured. There were (3) trials that were done in every area and the average water current expressed in meters per second were computed using the formula:

$$V=d/t$$

Where:

V=velocity, m/s;

d=distance traveled by ping-pong ball;

t=time for the ping-pong ball to travel from start to finish

Assessment of Local Status

The preserved collected samples were assessed locally based on their occurrences using the arbitrary scale of Mohagan and Treadaway, (2010).

It was based on the following data below:

Very rare (1-3 occurrences)

Rare (4-10 occurrences)
Common (11-20 occurrences)
Very Common (21-above occurrence)

Documentation

Documentation was done using a field notebook and a smartphone placed in a waterproof phone case. Photographs of representative species of macroinvertebrates found within Nasuli Spring were taken, including their distinctive morphological characters, for proper documentation and identification. Collected specimens were deposited at the University Museum of Central Mindanao University.

3. RESULTS

The study revealed thirteen (13) aquatic macroinvertebrate species collected in the three study stations of Nasuli Spring, Bangcud, Malaybalay City, Bukidnon. These species belonged to ten (10) orders and thirteen (13) families. A total of one thousand nine hundred twenty-four (1,924) individuals were collected (Table 1). Station 3 had the highest species richness with twelve (12) species (Figure 2). Species abundance was lowest in station 1 with three hundred fifty-two (352) individuals followed by seven hundred ten (710) individuals from station 3 and station 2 with eight hundred sixty-two (862) individuals. The K-plot revealed that the adequacy of sampling of aquatic macroinvertebrates was not reached for station 3 based on the Biodiversity Pro abundance plot since the species accumulation curve had yet reached its plateau curve (Figure 3).

Table 1 List of morpho-species composition with their total number of individuals and the local status assessment of aquatic macroinvertebrates found in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon

Morpho-species composition of aquatic macroinvertebrates						Number of individuals				Assessment
Phylum	Class	Order	Suborder	Family	Genus	S1	S2	S3	Total	Local Status
Arthropoda	Malacostraca	Decapoda		Gecarcinucidae	*Sundathelphusa* sp.(Fig. 33)	2	0	12	14	Common
				Atyidae	*Caridina* sp. (Fig. 23)	245	176	78	499	Very common
	Insecta	Odonata	Anisoptera	Chlorogomphidae (Fig. 28)		0	0	32	32	Very common
				Aeshnidae (Fig. 29)		0	0	24	24	Very common
				Platycnemididae (Fig. 30)		1	1	3	5	Rare
		Plecoptera	Systellognatha	Perlidae	*Neoperla* sp. (Fig. 26)	0	0	6	6	Rare
		Coleoptera	Polyphaga	Hydraenidae (Fig. 25)		1	3	14	18	Common
		Hemiptera	Heteroptera	Gerridae (Fig. 31)		0	0	23	23	Very common
		Diptera	Nematocera	Culicidae (Fig. 24)		20	46	68	134	Very common
		Trichoptera		Calamoceratidae (Fig. 32)		0	0	306	306	Very common
Mollusca	Gastropoda	Neotaenioglossa		Thiaridae	*Melanoides* sp. (Fig. 21)	51	537	104	692	Very common
		Architaenioglossa		Viviparidae	*Sinotaia* sp. (Fig. 22)	32	93	40	165	Very common
Annelida	Oligochaeta	Lumbriculida		Lumbriculidae (Fig. 27)		0	6	0	6	Rare
Total	4	10		13		352	862	710	1,924	

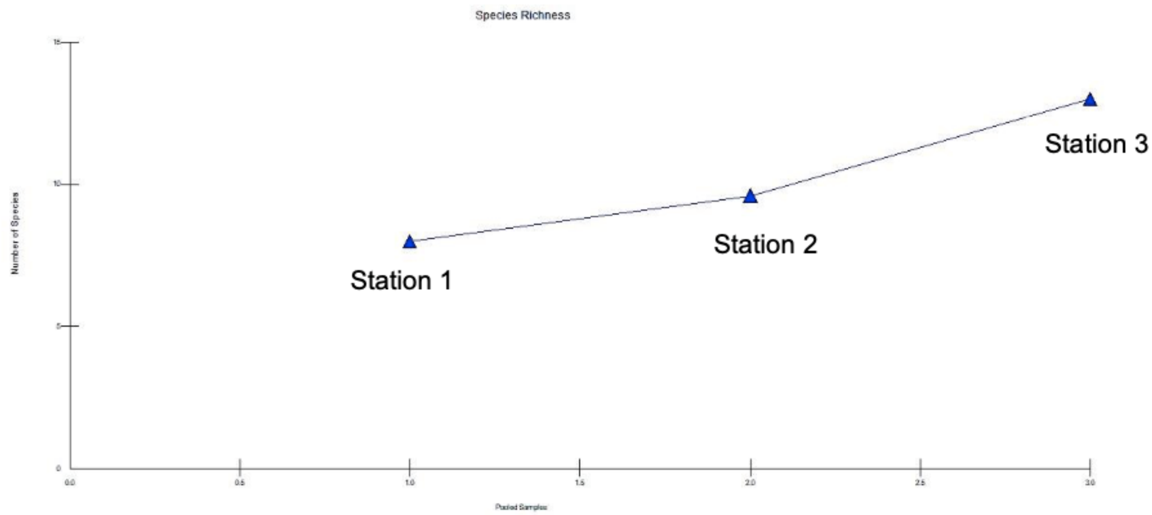

Figure 2 Species richness in the three study stations of Nasuli Spring

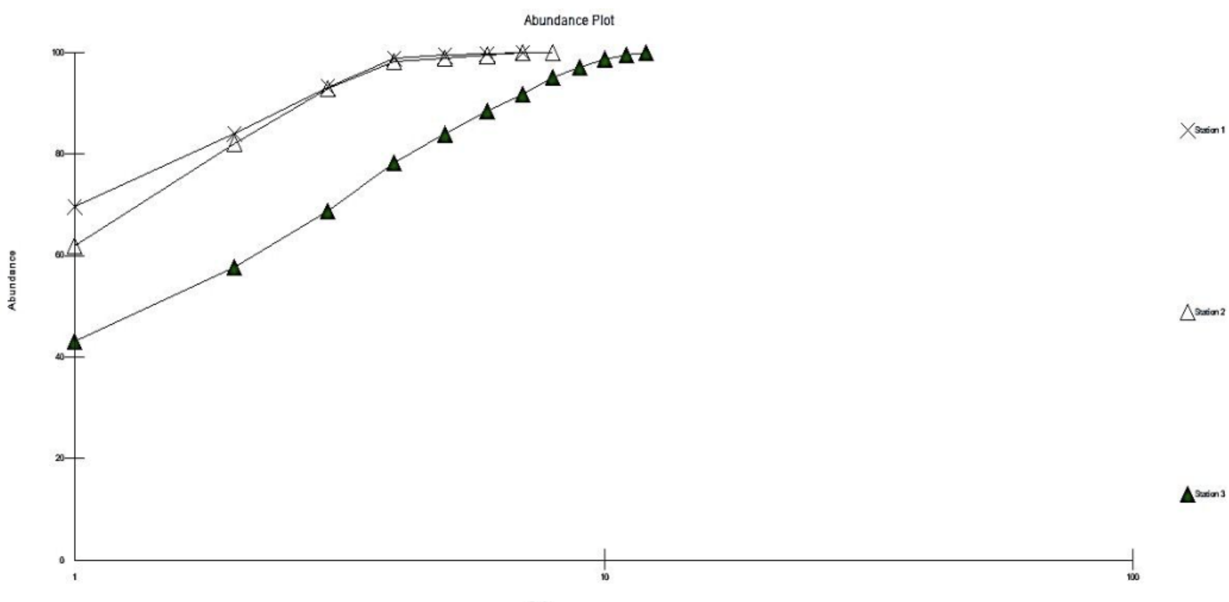

Figure 3 K Dominance plot of macroinvertebrates species composition in three study stations of Nasuli Spring

The mean Shannon Weiner index in three study stations in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon is H’=0. 564. There is a difference in the diversity values (Figure 4) between Station 1(H'=0.424), Station 2(H'=0.466) and Station 3(H'=0.803) (Table 2). Based on the classification scheme for the Shannon-Weiner diversity index of the Kruger scale (Table 3), this indicates that the diversity values for the three study stations are low. However, based on the species acquisition curve (Figure 3), it is possible that the value for study station 3 may yet increase with additional sampling considering that the curve has not yet reached asymptote.

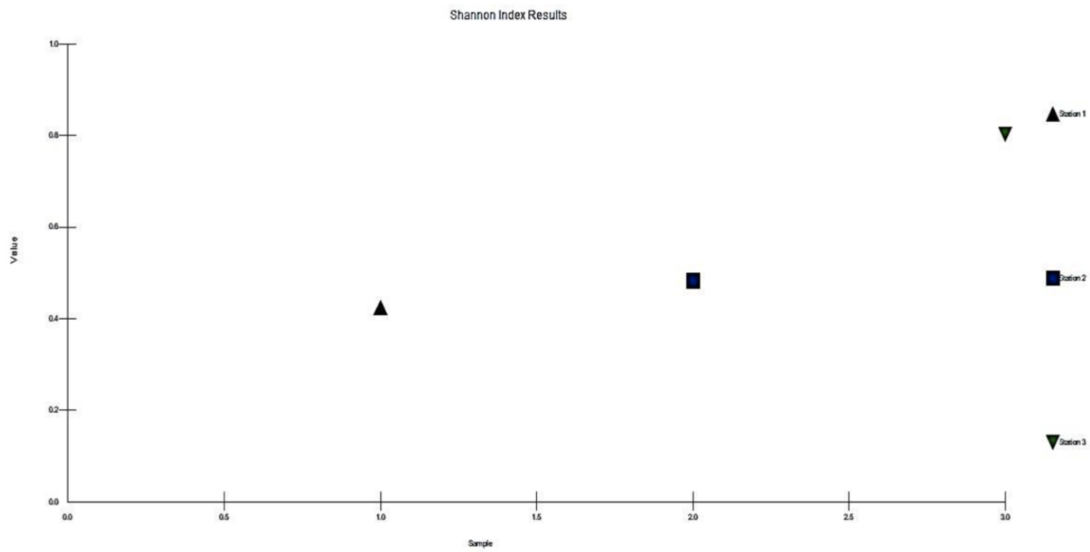

Figure 4 Shannon-Weiner plot of diversity of aquatic macroinvertebrates in the three (3) stations of Nasuli Spring

Table 2 Diversity of aquatic macroinvertebrates found in the three study stations of Nasuli Spring, Bangcud, Malaybalay City, Bukidnon

Index	*Station 1*	*Station 2*	*Station 3*
Shannon H' Log	0.424	0.466	0.803

Mean Shannon-Weiner diversity index (H')= 0.564

Table 3 Scale for Insect Diversity (Kruger, 2005)

Scale:
0.0-1.5= Low level of Diversity
1.6-3.0= Fair level of Diversity
4.0-6.0= High level of Diversity

Using the dendogram on cluster analysis of similarity of species composition, it showed that there were 2 clusters. Station 1 and station 2 were more similar compared to station 3 (Figure 5). Table 4 also indicates that almost all physicochemical properties of study stations 1, 2 and 3 are more likely the same. According to Mustapha and Omostosho, (2005), the water's physicochemical parameters significantly affect the aquatic organism composition, distribution and abundance. Macrobenthic organisms can be influenced positively or negatively by environmental physicochemical parameters, depending on their sources (Aura et al., 2011). This supports the observation of these stations' similarity index values.

Table 4 Average Physico-chemical parameters in three (3) study stations in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon

Parameters	Study Stations		
	Station 1	Station 2	Station 3
Water Temperature (ºC)	23.5	23.7	23.3
Water pH	6.96	7.01	6.98
Water Depth (cm)	90	86	54
Water Current (m/s)	2.64	3.32	0.34

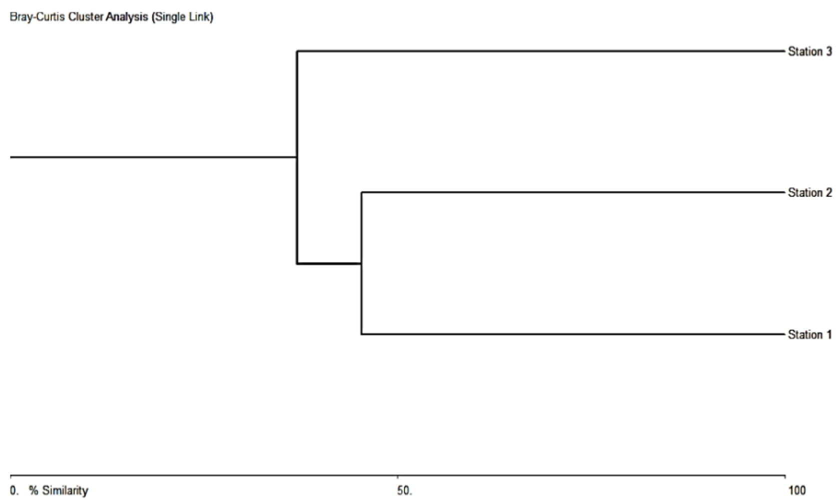

Figure 5 Dendogram on Bray-Curtis Cluster Analysis of Similarity on Species Composition in the three (3) study stations of Nasuli Spring

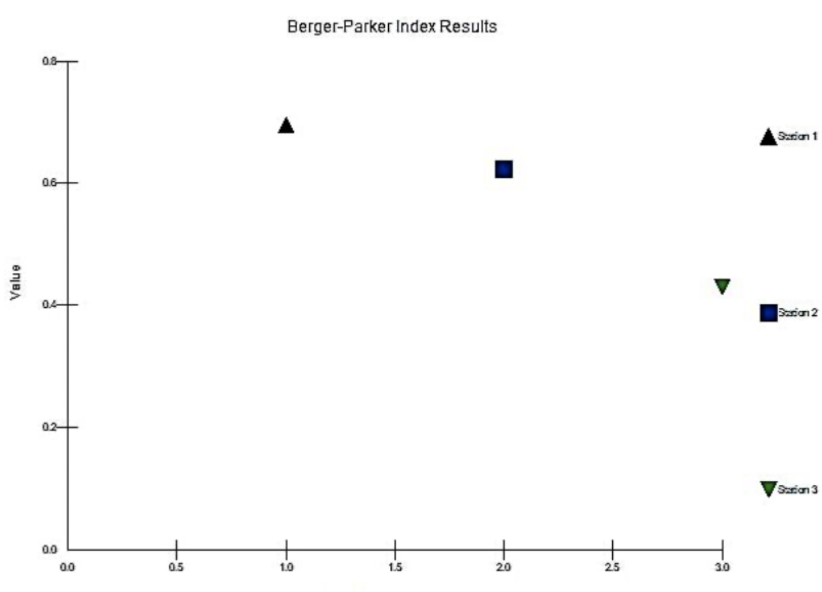

Figure 6 Berger-Parker Index plot in three study stations of Nasuli Spring

4. DISCUSSION

Most macroinvertebrates collected during the sampling belong to the phylum Arthropoda, primarily insects (Table 1). The existence of these animals contributes significantly to the ecosystem's organic matter processing function. These insects are critical in forested headwater streams because they help detritus decompose more quickly. Of all the macroinvertebrates observed during the sampling period, *Melanoides* sp. from the family Thiaridae got the highest number of individuals. It is the most abundant and it is frequently seen in station 2 as well as *Sinotaia* sp. from the family Viviparidae. Both families were classified as locally very common based on Mohagan and Treadaway, (2010) assessment of local status. This might be due to substrate and habitat preference. Among the three stations, only station 2 has a muddy substrate, while the rest of the station has a rocky and muddy combination in some parts of the area. According to Pinel-Alloul et al., (1996), the composition of bottom sediments significantly determines the number of Fresh water gastropod species, diversity and community structure. Oertli, (1995) also observed in his previous finding that a species' preference for a certain kind of substrate is expressed in terms of its abundance rather than its simple presence or absence. As benthic species, gastropods rely heavily on sediment for sustenance and are highly polyphagous, meaning they consume various foods. In addition, gastropods have a temperature preference and also prefer slow-running water (Tamburi and Martin, 2009), which correlates with the data in (Table 4). The water temperature in all the stations was almost the same, which is why these gastropods like *Melanoides* sp. and *Sinotaia* sp. thrived in all study stations and the high abundance of gastropods in stations 2 and 1 was also because of the slow water current. The water current for stations 2 and 1 was 3.32 m/s and 2.64 m/s, respectively, while the water current for station 3 was the fastest at 0.34 m/s.

Caridina sp. from the family Atyidae, on the other hand, has the second-highest number of individuals collected. It is present in all the study stations, especially near the aquatic grasses. Based on the assessment of the local status of Mohagan and Treadaway, (2010), the family Atyidae is also classified as very common. Table 4 shows that the water temperature for all the study stations was almost the same, but the presence of aquatic grasses in stations 1 and 2 is also a factor for the abundance of this species. According to Oscoz et al., (2011), the atyidae family prefers calm, well-oxygenated waters rich in macrophytes. They can withstand extraordinary temperature and salinity swings.

The family Culicidae was also found in all the 3 study stations of the area. This family was also classified as locally very common based on the assessment of local status. According to Iowa State University Entomology, (2010), mosquito larvae may be found in any area with water, whether natural or artificial. Examples include lakes, swamps, streams, temporary rain-filled depressions, ponds, irrigation drains, dams, tire ruts and backyard fixtures like bird baths and septic tanks. Larvae can survive in water contaminated with organic contaminants, which explains why they may be found in various settings. The larvae are often found amid plants in standing water in these various settings. Adult females can determine the chemical and biological condition of a body of water, which enables them to choose the optimal choice for where to lay their eggs.

Family Hydraenidae is also present in all the study stations and its abundance was higher in station 3 with 14 individuals, followed by station 2 with four individuals and lastly, station 1 with one individual (Table 1). This can be due to biotic and abiotic factors that may influence the abundance of the species. Based on the Berger-Parker index result (Figure 6), it showed that among all the study stations, station 1 is the most disturbed (69.602%), followed by station 2 (62.369%) and station 3 at 43.099%. Human activities may cause the high percentage of disturbances in station 1. Station 1 is a common area for visitors to swim. A community of people is nearby and the surroundings have already been renovated up to station 2. Although station 2 is not frequently visited by visitors, station 2 is also an area where the workers anchor their bamboo rafts after doing their daily tasks. According to Caruso and Migliorini, (2007), disruption may reduce the number of sensitive species and eventually result in their extinction, enabling opportunistic species to colonize; however, the process by which the successful species is recognized remains unclear. The findings align with other researchers like Magbanua et al., (2019), Cuadrado and Calagui, (2017) and Arimoro and Keke, (2016), suggesting that land-based activities might stress aquatic organisms, reducing the abundance and possibly species composition. Hydraenid beetles inhabit a range of riparian, littoral and aquatic environments, including inland salt lakes (Perkins, 2005). They are often plentiful as a family along the banks of grave rivers and streams.

Additionally, most Hydraena species require shade with some leaf litter or aquatic plants. *Neoperla* sp. from the family Perlidae collected only six individuals during the sampling, mainly found in station 3. Based on the assessment local status of Mohagan and Treadaway, (2010), this family was classified as rare. Family Perlidae or the family of stoneflies, spend most of their life in water as larvae, creeping around the bottoms of streams and rivers and adhering to the undersides of rocks and woody debris. According to the Minnesota Pollution Control Agency, (2017), stoneflies are vulnerable to changes in water quality. They are susceptible to changes in dissolved oxygen levels and water temperature that need a high dissolved oxygen concentration to survive (DO). This also corroborates the statement from Mustapha and Omostosho, (2005) that the water's physicochemical parameters immensely

affect the aquatic organism's composition, distribution and abundance. When the DO level drops or the temperature rises, stoneflies go extinct.

Species from the family Lumbriculidae were also collected. According to Yule and Yong, (2004), the family Lumbriculidae is found in various habitats, from springs and groundwater to rivers and estuaries and from small ephemeral pools to the profundal depths of large lakes. However, the result of the study showed that the family Lumbriculidae was classified as rare in the assessment of local status by Mohagan and Treadaway, (2010) and it is seen only in station 2. The small abundance of this species in the spring may be due to the presence of other organisms like fish. According to Robert, (2021), most fish are opportunistic feeders that will consume anything, even worms. Fish are comfortable eating worms and even small fish species can digest small worms. Worms have a high protein concentration, which fish need for energy, growth and survival. Many fish are attracted to worms due to their earthy taste and widespread availability in their environments.

Larvae of Chlorogomphidae and Aeshnidae and adult forms of the Family Platycnemididae and Gerridae were also evident and dominant at station 3. Since the area is the least disturbed and epiphytes, vines, grasses and different trees like bamboo and palm trees were also observed along the site, it is feasible for these animals to flourish in this station. According to Baruah and Saikia, (2015), dragonflies and damselflies are very habitat-specific and require both flowing and still water for reproduction; they are also sensitive to landscape changes and serve as good indicators of the health of Fresh water ecosystems. Family Gerridae, on the other hand, is known to be highly efficient predators of other insects, especially larvae mosquitoes. According to the Missouri Department of Conservation, water striders are predators that specialize in feeding on land insects caught on the water's surface. Since most insects are found at station 3, Table 1 also showed that adult mosquitoes dominate in station 3. Therefore, the species from the family Gerridae may also thrive in that station.

Family Calamoceratidae from the order Trichoptera was also present. It is abundant in station 3 and was classified as locally very common based on Mohagan and Treadaway, (2010). In all sorts of natural aquatic habitats, Trichoptera is numerous. They also depend on dissolved oxygen for breathing since they are apneustic. Caddisfly larvae serve a crucial function in cleansing their watery habitat. Case-making caddisflies consume plants to make their cases, indirectly removing organic detritus from their environments and ecological niches. They consume almost all living and nonliving organic substances in aquatic bodies (Prommi, 2018). Family Gecarcinucidae was also evident during the sampling. Based on the assessment of local status, it showed that the family Gecarcinucidae was classified as common and abundant in station 3. Crabs in fresh water play a crucial role in the decomposition of nutrients from fallen organic matter in streams. Crab enclosures had quicker decomposition rates than those without crabs, suggesting that crabs' manipulation and ingestion of leaves had a more significant influence than their consumption of other detritivores and shredders (Yang et al., 2020).

5. CONCLUSION

Nasuli Spring, Bangcud, Malaybalay City, Bukidnon is home to thirteen (13) aquatic macroinvertebrate families belonging to three (3) phylum, four (4) classes and ten (10) orders, of which ten (10) families were from phylum Arthropoda namely, Gecarcinucidae, Atyidae, Chlorogomphidae, Aeshnidae, Platycnemididae, Perlidae, Hydraenidae, Gerridae, Culicidae, Calamoceratidae. Two (2) families were from phylum Mollusca, namely, Thiaridae and Viviparidae and one (1) family from phylum Annelida, namely, Lumbriculidae.

From the entire sampling period, 1,924 individuals of aquatic macroinvertebrates were collected. Station 3 showed the highest species richness, while Station 2 showed the highest species abundance. The Shannon-Weiner diversity index revealed a low level of diversity in Nasuli Spring, Bangcud, Malaybalay City, Bukidnon based on the Kruger scale. The Bray-Curtis cluster analysis showed that Stations 1 and 2 are more closely related than station 3 and based on the Berger-Parker index, station 1 is the most disturbed (69.602%), followed by station 2 (62.369%) and station 3 at 43.099%.

From the 13 species of aquatic macroinvertebrates collected, eight were locally very common, namely, from the families of Atyidae, Chlorogomphidae, Aeshnidae, Gerridae, Thiaridae, Viviparidae, Culicidae and Calamoceratidae. 2 were locally common namely, from the families of Gecarcinucidae and Hydraenidae and 3 were rare namely, from the families of Platycnemididae, Perlidae and Lumbriculidae. The assumption that the aquatic macroinvertebrate diversity is high in Nasuli Spring, Bangcud, Malaybalay City, is not accepted.

The study recommends a longer time to investigate the areas, especially in station 3 and a long-term survey is needed to monitor species abundance for satisfactory results of species to be collected. Monitoring of gastropods is also recommended because of its noted association as host to some parasites.

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Informed consent
Not applicable.

Ethical approval
The Animal ethical guidelines are followed in the study for species observation & identification.

Conflicts of interests
The authors declare that there are no conflicts of interests.

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Data and materials availability
All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Arimoro FO, Keke UN. The intensity of human-induced impacts on the distribution and diversity of macroinvertebrates and water quality of Gbako River, North Central, Nigeria. Energy Ecol Environ 2016; 2(2):143–154. doi: 10.1007/s40974-016-0025- 8
2. Aura CM, Raburu PO, Herrmann J. Macroinvertebrates' community structure in rivers Kipkaren and Sosiani, river Nzoia basin, Kenya. J Ecol Nat Environ 2011; 3:39-46.
3. Baruah C, Saikia PK. Abundance and Diversity of Odonates in Different Habitats of Barbeta District, Assam, India. Int Res J Biol Sci 2015; 4(9):17-27. https://www.researchgate.net/public cation/320004110_Abundance_and_Diversity_of_Odonates_in_Different_Habitats_of_Barpeta_District_as sam_India
4. Bouchard RW Jr. Guide to aquatic macroinvertebrates of the Upper Midwest. Water Resources Center, University of Minnesota, St Paul MN 2004; 208.
5. Caruso T, Migliorini M. A new formulation of the geometric series with applications to oribatid (Acari, Oribatida) species assemblages from human-disturbed Mediterranean areas. Ecol Modell 2007; 195:402–406
6. Cuadrado JT, Calagui LB. Aquatic Macroinvertebrates composition, diversity and richness in Agusan River tributaries, Esperanza, Agusan del Sur, Philippines. J Biodivers Environ Sci (JBES) 2017; 10(3):25–34. http://www.in nspub.net
7. Curriculum Research & Development Group (CRDG). Exploring our Fluid Earth. What is an Invertebrate? 2022. https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/what-invertebrate
8. Fofonoff P, Ruiz G, Steves B, Simkanin C, Cariton J. National Exotic Marine and Estuarine Species Information System 2018. http://invasions.si.edu/nemesis/
9. Freitag H. Aquatic Heteroptera of the Lake Manguao Catchment, Palawan and New Rank of Rhagovelia Kawakamii Hoberlandti Hungerford & Matsuda 1961. Philipp J Syst Biol 2013; 6:54–80.
10. Garcia MP, Paz-Alberto AM, Abella TA, Sace CF, Claudio EG, Gabriel AG. Assessment of the diversity of macro aquatic species in Amburayan River in Kapangan, Benguet in the Philippines. Open J Mar Sci 2018; 08(03):323–354. doi: 10.4236/ ojms.2018.83018
11. Iowa State University Entomology. Department of Entomology 2010. www.ent.iastate.edu/
12. IUCN. Version 2019-2. The IUCN Red List of Threatened Species 2019. http://www.iucnredlist.org
13. Karam-Gemael M, Decker P, Stoev P, Marques MI, Chagas A. Conservation of terrestrial invertebrates: A review of IUCN and Regional Red Lists for Myriapoda. Zookeys 2020; 930:221 –229. doi: 10. 3897/zookeys.930.48943

14. Kruger MA. The effects of insect diversity on three production fields: An apple orchard, a field and a garden. Sydney Australia 2005.
15. Magbanua FS, Salluta JCRB, Deborde DDD, Hernandez MBM. Benthic Macroinvertebrates of the University of the Philippines Diliman Campus Waterways and Their Variation across Land Use in an Urban, Academic Landscape. Sci Diliman 2019; 31:5–24.
16. Malaybalay City Tourism Office. Habitat Description of Nasuli Spring, Malaybalay City 2021.
17. Minnesota Pollution Control Agency. Stonefly 2017. https://www.pca.state.mn.us/stonefly#:~:text=Larval%20stoneflies%20are%20important%20to,dissolved%20oxygen%20and%20water%20temperature.
18. Mohagan AB, Treadway CG. Diversity and status of butterflies across vegetation type in Mt. Hamiguitan, Davao Oriental. Asian J Biodivers 2010; 1.
19. Mustapha MK, Omostosho JS. An assessment of the physicochemical properties of Maro Lake. Afr J App Zool Environ Biol 2005; 7:73-77.
20. Nelson SM, Wydoski R. San Diego River Invertebrate Monitoring Program-Final Report. Denver, Colorado: US Department of the Interior Bureau of Reclamation Technical Service Center Denver 2008.
21. Oertli B. Spatial and temporal distribution of the zoobenthos community in a woodland pond (Switzerland). Hydrobiologia 1995; 300-301(1):195-204.
22. Oscoz J, Galicia D, Miranda R. Identification guide of Fresh water macroinvertebrates of Spain. Springer Netherlands 2011. doi: 10.1007/978- 94-007-1554-7
23. Pelingen AL, Murányi D, Freitag H. An additional new species and records of Neoperla Needham, 1905 (Plecoptera, Perlidae) from the Philippines. Tijdschrift Voor Entomologie 2021; 164(1-3):91–105. doi: 10.1163/22119434-bja10016
24. Perkins PD. A revision of the South African endemic humicolous beetle genus *Discozantaena* Perkins and Balfour-Browne (Coleoptera: Hydraenidae). Zootaxa 2005; 915:1–48.
25. Pinel-Alloul B, Methot G, Lapierre L, Wilsie A. Macroinvertebrate community as a biological indicator of ecological and toxicological factors in Lake Saint-Fran cois (Quebec). Environ Pollut 1996; 91(1):65-87.
26. Prommi TO. Ecological and Economic Importance of Trichoptera (Aquatic Insect). J Food Health Bioenviron Sci 2018; 11(1).
27. Robert T. Why do fish like worms? (Explained) 2021. https://www.eatingthewild.com/why-do-fish-like-worms/
28. Sheikh AH, Thomas M, Bhandari R, Bunkar K. Light Trap and Insect Sampling: An Overview. Int J Curr Res 2016; 8(11):4086 8–40873.
29. Tamburi N, Martin. Feeding rates and food conversion efficiencies in the apple snail Pomacea canaliculate (Caenogastropoda: Ampullariidae). Malacologia 2009; 51(2):2 21-232.
30. Walker KF, Corbin TA, Cummings CR, Geddes MC, Goonan PM, Kokkin MJ, Kokkin MJ, Lester RE, Madden CP, Mc-Evoy PK, Whiterod N, Zukowski S. Fresh water macro-invertebrates 2018. doi: 10.20851/natural-history-cllmm-3.5
31. Wallace I. The Beginner's Guide to Caddis (Order Trichoptera) 2003; 62:15–26.
32. Wallace JB, Webster JR. The role of microinvertebrates in stream ecosystem function. Annu Rev Entomol 1996; 41:115-139.
33. Yang C, Wenger SJ, Rugenski AT, Wehrtmann IS, Connelly S, Freeman MC. Fresh water Crabs (Decapoda: Pseudothelphusidae) increase rates of leaf breakdown in a Neotropical headwater stream. Fresh water Biology 2020; 65 (10):1673–1684. doi: 10.1111/fwb.13524
34. Yule CM, Yong HS. Fresh water Invertebrates of the Malaysian Region. Academy of Science Malaysia, Kuala Lumpur, Malaysia 2004; 861.
35. Zamin TJ, Baillie JE, Miller RM, Rodriguez JP, Ardid A, Collen B. National Red Listing Beyond the 2010 Target. Conserv Biol 2010; 24:1012–1020. doi: 10.1111/j.1523-1739.2010.01492.x